ABSTRACT OF THE DISCLOSURE

To amplify and compress optical pulses in a multi-mode (MM) optical fiber, a single-mode is launched into the MM fiber by matching the modal profile of the fundamental mode of the MM fiber with a diffraction-limited optical mode at the launch end. The fundamental mode is preserved in the MM fiber by minimizing mode-coupling by using relatively short lengths of step-index MM fibers with a few hundred modes and by minimizing fiber perturbations. Doping is confined to the center of the fiber core to preferentially amplify the fundamental mode, to reduce amplified spontaneous emission and to allow gain-guiding of the fundamental mode. Gain-guiding allows for the design of systems with length-dependent and power-dependent diameters of the fundamental mode. To allow pumping with high-power laser diodes, a double-clad amplifier structure is employed. For applications in nonlinear pulse-compression, self phase modulation and dispersion in the optical fibers can be exploited. High-power optical pulses may be linearly compressed using bulk optics dispersive delay lines or by chirped fiber Bragg gratings written directly into the SM or MM optical fiber. High-power cw lasers operating in a single near-diffraction-limited mode may be constructed from MM fibers by incorporating effective mode-filters into the laser cavity. Regenerative fiber amplifiers may be constructed from MM fibers by careful control of the recirculating mode. Higher-power Q-switched fiber lasers may be constructed by exploiting the large energy stored in MM fiber amplifiers.